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SPECIAL FEATURES OF THE STRONG INTERACTION OF A PLASMA WITH A MAGNETIC FIELD AS IT EXPANDS RADIALLY IN A DISK CHANNEL

by

A. Yu. Kerkis, V.S. Sokolov, et al.

FOREIGN TECHNOLOGY DIVISION

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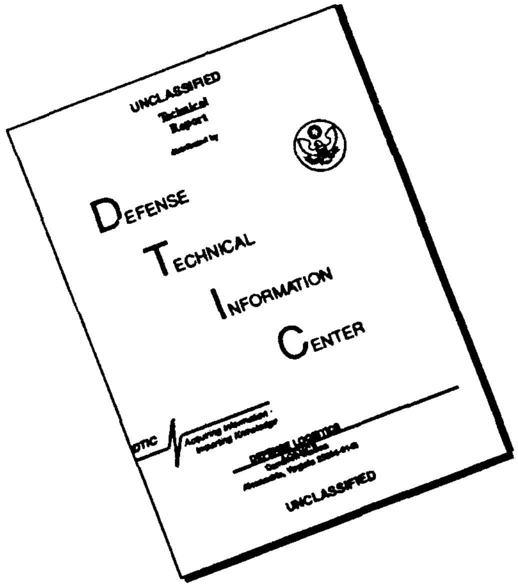

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Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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SPECIAL FEATURES OF THE STRONG INTERACTION OF A PLASMA WITH A MAGNETIC FIELD AS IT EXPANDS RADIALLY IN A DISK CHANNEL

Kerkis, A.Yu., Sokolov, V.S.,
Trynkina, N.A., Fomichev, V.P.,

The investigation concerns the process of expansion of a plasma in a disk channel when a transverse magnetic field is present. The layout of the experimental unit is shown in Figure 2.19. The plasma source is a coaxial electric discharger, on which a capacitor bank of the IMM-5-150 type is discharged. The initial air pressure comprises 0.7-1.0 mm Hg. The plasma which forms as a result of the electric discharge moves along a straight tube, which is a continuation of the discharger, at a velocity of up to 20 km/s. This tube, which has a length of 30 cm and diameter of 5 cm, terminates in a disk channel with a width of 2 cm. The process develops in such a manner that the plasma, following impact on the end of the straight tube, is expanded in the disk channel. The leading edge of the moving plasma, already at a radius of 60 mm, is a shock wave, traveling over a quiescent gas at a velocity of up to 10 km/s (without a magnetic field). The results of the measurement of pressure along the length of the disk channel at different moments of time when the magnetic field is absent are given in Figure 2.20. Also given are the estimates and the indirect measurements of distribution of electrical conductivity over the radius at different moments of time. These measurements in combination with data on pressure showed that the change in the parameters of the gas beyond the cylindrical shock wave take place primarily as a result of its adiabatic expansion.

In this case the presence of a transverse magnetic field, when its strength exceeds a certain critical magnitude, leads to a qualitative change in the nature of expansion of the gas. Direct measurements of the current density in the plasma, changes in the strength of the magnetic and electric fields, pressure (Figure 2.21), and also high-speed photography with the help of an SFRL (in the mode of photosweep and time magnifier), lead to the detection of a clearly expressed current layer (Figure 2.22), appearing in the gas beyond the direct shock wave and leading, as a result of its intensive stagnation in the magnetic field, to the formation of a reflected shock wave. In this case the measured current density reaches a magnitude of 2000 A/cm^2, which at a field strength of $\sim$4000 Oe under the conditions of the experiment leads practically to the complete standstill of the gas in this zone. Estimates show that the magnitude of electrical conductivity inside the current layer reaches values of 120-150 mho/cm (without a magnetic field it is equal to 5-10 mho/cm).

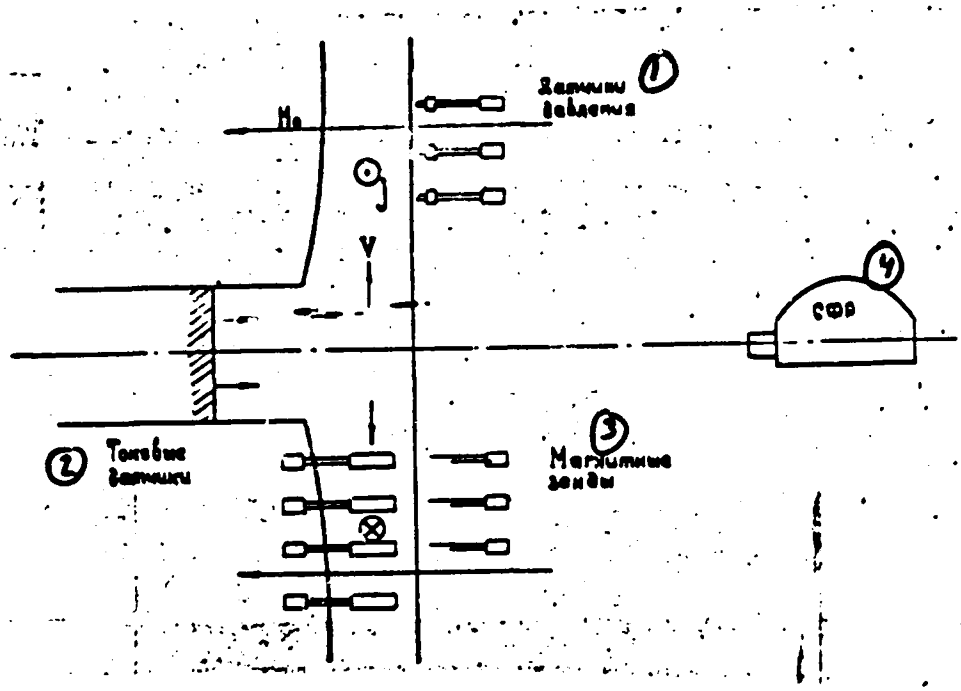

Figure 2.19.

Key: (1) Pressure sensors; (2) Current sensors; (3) Magnetic probes; (4) SFR.

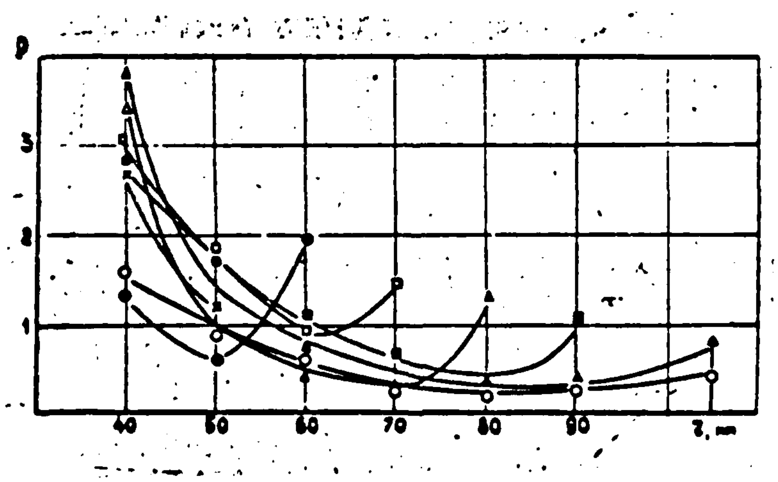

Figure 2.20.

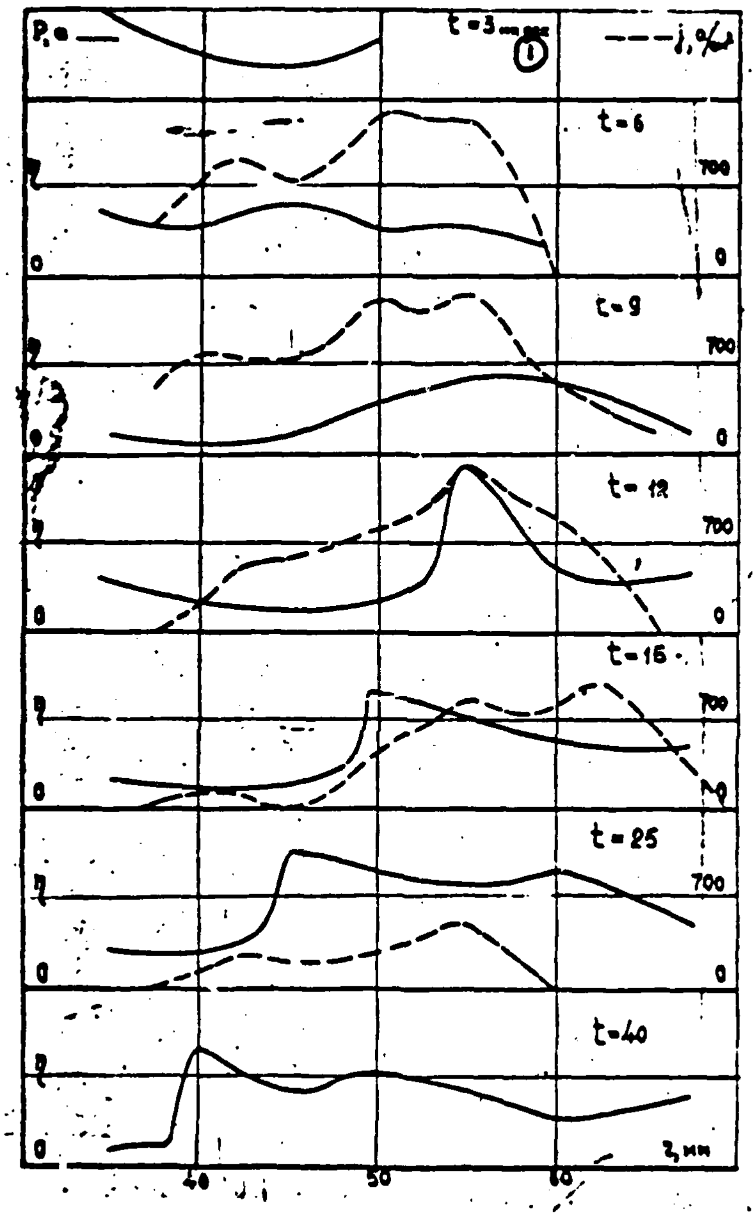

Figure 2.21.

Key: (1) μs.

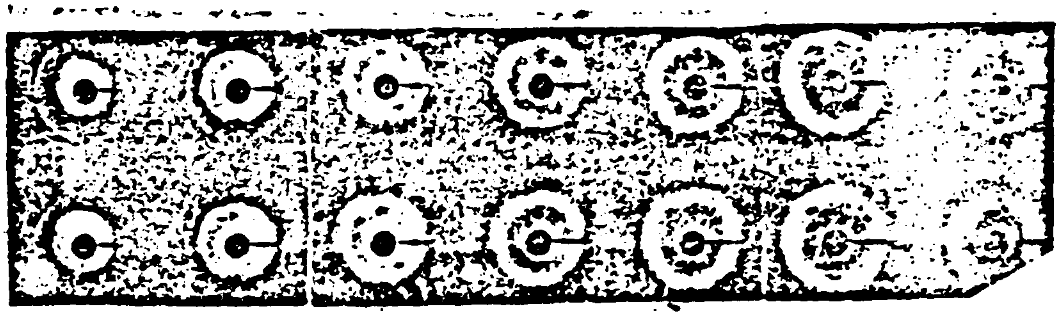

Figure 2.22. Frame-by-frame photography of the process. Exposure time for one frame 1.33 μs. Sequence of frames: from top to bottom, from left to right.

During the course of the experiment attention was turned to the stability of the current layer. It was revealed that it had exceptional stability as a geometric formation. In a number of cases on the external boundary of the layer a picture developed which was characteristic for Rayleigh-Taylor instability, which, however, disappeared quite rapidly, leading to the complete restoration of the structure of the current layer. The process of expansion of the conducting gas in a transverse magnetic field, which is being investigated at the present time, and which is accompanied by the formation of a clearly expressed current layer, coincides in its nature with the analogous process which was described in [1], and thereby confirms experimentally the conclusions of this work, obtained on the basis of a numerical solution of equations of magnetic hydrodynamics.

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